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PROCEDURE FOR TESTING THE FIRE-RESISTANCE OF BRATTICE CLOTH AND RIGID VENTILATION DUCTING USING THE HORIZONTAL FLAMMABILITY TESTER

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MICROMEDIA

PROCEDURE FOR TESTING THE FIRE-RESISTANCE OF BRATTICE CLOTH AND RIGID VENTILATION DUCTING USING THE HORIZONTAL FLAMMABILITY TESTER

by

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ABSTRACT

The horizontal flammability test has been incorporated into the Canadian Standards Association Standard CAN/CSA-M427-M91, published in February 1991. The present report describes in detail the procedure for carrying out this test in the Canadian Explosive Atmospheres Laboratory, as well as a discussion of the errors involved.

KEYWORDS: Brattice cloth, ventilation ducting, flammability

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MARCHE À SUIVRE POUR VÉRIFIER LA RÉSISTANCE À LA CHALEUR DES CONDUITS D'AÉRAGE RIGIDES ET DE L'ÉTOFFE DES CLOISONS D'AÉRAGE AU MOYEN DE L'APPAREIL HORIZONTAL D'ESSAI D'INFLAMMABILITÉ

par

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RÉSUMÉ

L'essai mené au moyen de l'appareil horizontal d'essai d'inflammabilité a été incorporé dans la norme CAN/CSA-M427-M91 de l'Association canadienne des normes, publiée en février 91. Le présent rapport donne le détail de la marche à suivre pour mener cet essai au Laboratoire canadien de recherche sur les atmosphères explosives et un exposé des erreurs possibles.

MOTS CLÉS : étoffe de la cloison d'aérage, conduits d'aérage, inflammabilité

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TABLE OF CONTENTS

	Page
ABSTRACT	i
RÉSUMÉ	ii
INTRODUCTION	1
SAFETY CONSIDERATIONS	1
EQUIPMENT REQUIRED	2
PREPARATION	2
TEST	3
SHUT-DOWN	5
SOURCES OF ERROR	6
TOXIC FUME MEASUREMENTS	7
WORKSHEET	9

INTRODUCTION

The new Canadian Standard CAN/CSA-M427-M91, "Fire-Performance and Antistatic Requirements for Ventilation Materials", developed under authority of the Mine Safety Steering Committee of the Canadian Standards Association, was published in February 1991. The main test used is the "horizontal flammability test" (HFT), which is the subject of the present report. The apparatus and procedure are very close to the "standardized small-scale flammability tester" (S^3FT), developed jointly by the U.S Bureau of Mines and the U.S. Mine Safety and Health Administration (MSHA). Results from the CANMET HFT and the MSHA S^3FT should be identical, apart from random scatter, intrinsic to the method.

The M427 standard replaces the EMR Specification which used, originally, a small-scale flame test, supplemented since 1985 by an interim test carried out in the propane gallery. The present Standard will ensure that only products having a high degree of fire-resistance will be certified.

SAFETY CONSIDERATIONS

1. Wear safety face-shield, safety shoes and Nomex coveralls while working in the flammability lab.
2. During the test, wear a gas mask suitable for organic vapours and hydrogen chloride.
3. Keep flammable materials out of the flammability room, as well as any unnecessary equipment or materials.
4. Two persons are required to conduct these tests.
5. No more than two visitors are allowed in the room during testing, in order to prevent any problem exiting the laboratory under emergency conditions.
6. Observe the normal safety rules for handling the cylinder of methane.
7. Keep fire extinguisher (5 or 10 lb. CO_2 type) nearby. Verify that it is at least half full.

8. Drippings from burning materials may remain hot for several minutes; use leather gloves to remove aluminum foil and sample remains after the test.

EQUIPMENT REQUIRED

1. Flammability Tester, located in flammability laboratory.
2. Solarflo Type U-10 burner (with 12 #640 jets) with metal handle.
3. Technical grade methane cylinder with Model 8-2-350 regulator.
4. Metal rod to hold brattice cloth sample.
5. Wire to hold rigid tubing sample.
6. Vane anemometer.
7. Large paper clamps (4).
8. Tape measure.
9. Scissors.
10. Masking tape, matches.
11. Short metal rod (min. 100 mm long) for use in lighting burner.
12. Aluminum foil.
13. Tripod.
14. Stopwatches (2).

PREPARATION

1. Condition the samples in the environmental chamber for at least 24 h at 20°C and 50% R.H.
2. Turn on propane gallery scrubber after ensuring that the water level in the sump is up to the bar. Add 500 mL defoamer if the water appears to be foaming. (Check every half hour.) Add 1 kg of soda ash if the pH of the water in the sump is below 7.
3. Open the damper on the propane gallery that leads to the flammability room.
4. Angle the front end of the apparatus out from the wall.
5. If necessary, wrap aluminum foil around holder rod (brattice cloth tests only).

6. Line floor of flammability tester with aluminum foil.
7. If necessary, cut samples to correct size (6 required):
   (a) brattice cloth: 1020 mm by 1220 mm
   (b) rigid tubing: 1220 mm long.
8. Check that the emergency door opens easily and the way is clear of snow.
9. Check that there is no leakage from the methane cylinder or regulator.

TEST

1. Install sample:
   (a) Brattice cloth: (i) draw line 900 mm from bottom of sample.
   (ii) roll sample around metal rod so that the line is just below the rod.
   (iii) clamp sample to rod with paper clamps.
   (iv) place rod with sample on hooks in apparatus - bottom of sample should be 100 mm from floor.
   (b) Rigid tubing: Suspend sample from the hooks with the wire so that the bottom of the sample is 100 mm from the floor.

2. Keep the door to the laboratory shut throughout the test, otherwise the draft may seriously affect the results.

3. Adjust the flow rate:
   (a) Place the vane anemometer on the tripod near the front of the apparatus in the centre.
   (b) Turn on the roof fan to maximum speed.
   (c) For the still-air tests, open the damper on the apparatus as much as possible without causing the anemometer to indicate flowing air.

Note: *To satisfy this condition, the damper may be from full open to less than one-quarter open, depending on the atmospheric conditions.*

(d) For the flowing air tests, open the damper completely and adjust the fan speed so that the velocity is 0.65 m/s. (125 fpm).

Note: *The fan speed required may be from 0 to 40, depending on the atmospheric conditions.*

4. Light the burner:
   (a) Place burner on concrete floor.
   (b) Open cylinder valve, adjust outlet pressure to 11 kPa.
   (c) Tape two matches to end of short metal rod.
   (d) Crack open the outlet valve on the regulator.
   (e) Light the burner
   (f) Open the outlet valve completely.

5. Operator #1:
   (a) Brattice cloth:
      (i) apply the entire length of the burner to the bottom of the sample;
      (ii) follow the melting sample with the burner, in both the vertical and horizontal directions in order to keep the entire length of the burner under the sample and about 50 mm from the bottom edge;
      (iii) withdraw the burner from the sample after 25 s or when the material has shrunk back to the rod, whichever occurs first.

   (b) Rigid tubing:
      (i) place the burner so that two-thirds is under the sample;
      (ii) withdraw the burner after 60 s.

6. Operator #2 measures:
   (a) the time that fragments on the floor are burning during application of the burner; plus
   (b) the time that flame persists after the burner has been removed, whether the flame is on the hanging material or fragments on the floor.

7. Carry out three tests in still air and three tests in flowing air.

8. The product fails if:
   (a) the total duration of burning exceeds 120 s in any test; or,
   (b) the mean duration of burning in the still air tests exceeds 60 s; or,
   (c) the mean duration of burning in the flowing air tests exceeds 60 s; or,
   (d) the far end of the sample in any test is damaged.

Note: Generally, the still air test is more severe than the flowing air test for brattice cloth; the opposite is true for rigid tubing.

SHUTDOWN

1. Ensure that the methane cylinder valve is closed.
2. Close the damper on the flammability tester.
3. Close the damper on the propane gallery.
4. Turn off the propane gallery.
5. Turn off the roof fan.
6. Replace the aluminum foil as required.
7. Push the apparatus back against the wall.
8. Weigh fire extinguisher, if it was used. If it is less than half full, arrange to have it refilled.

SOURCES OF ERROR

Experiments carried out on light-weight flexible materials indicate that air velocity greatly affects the results: the closer to still air, the more severe is the test. In the interim test used during the past several years, it was impossible to achieve true still air. Even in the tests carried out earlier to evaluate the apparatus, true still air conditions were impossible to achieve. Now that a dedicated flammability laboratory has been built, tests can be carried out at zero velocity. This means that some materials that passed the interim flame test may fail the new test. The roof fan does slightly affect the air velocity, thus, it must be turned on before the air velocity in the apparatus is measured. The draft from the entrance door substantially affects the air velocity; it is vital that the door be kept closed during velocity measurements and the test itself.

In still air, even 2 mil polyethylene hung vertically without much movement. In earlier tests, light weight materials had oscillated considerably in the chamber, causing difficulty in conducting the test. However, although the air velocity is fairly uniform throughout the chamber, there remains sufficient variability to cause oscillations in light-weight materials when conducting the flowing-air tests. It is advantageous to carry out still-air tests first; if the product fails these, it is unnecessary to carry out the flowing-air tests.

The major source of variability in the test on brattice cloth is due to the necessity of the burner to follow the material upwards and inwards, because many polymeric materials shrink. The shrinkage is irregular and rapid, often with pieces breaking off from the hanging material, so that there is no straight bottom edge. The results may, therefore, be somewhat operator dependent. From the writer's experience, flexible materials can be divided into three groups. The first group consists of materials containing no or little fire-retardants in the formulation; molten

material from the hanging material forms pools on the floor which continue to burn after the burner has been removed. In addition, the fragments burn while falling; flame usually persists on the hanging material after removal of the burner. These products would fail the interim test, but may have passed the old EMR specification, which was identical to that of the National Coal Board. The second group consists of products in which the molten material may be burning while falling, but self extinguishes on the floor. A flame usually, but not in every trial, persists on the hanging material after the burner has been removed and continues to burn for at least several minutes, possibly until all the material has been consumed or shrunk back to the rod. It is unlikely that a member of the second group would produce a false pass, because the test is carried out three times. The third group consists of materials which may produce molten material but it would not burn while falling. Any flame that persists after the burner is removed would self-extinguish within a few seconds.

The rigid tubing obviously does not have the same technical problems in testing as the flexible materials. Unreproducibility of results, therefore, probably would be traceable to inhomogeneities in samples, rather than testing difficulties.

TOXIC FUME MEASUREMENTS

Dräger tube measurements were carried out on the fumes emitted from samples of brattice cloths during testing in the horizontal flammability tester. The tests were carried out under "worst conditions": the damper to the propane gallery was shut (normally during testing it is at least partly open) and the roof fan was off (normally it is on). The sampling location was just inside the apparatus.

The first sample tested was non-fire-resistant polyethylene film, which was chosen because it burns well. The CO 10/b tube was used: 10 strokes yielded no detectable indication, which means that

the [CO] was less than about 2 ppm.

The second sample was a yellow vinyl brattice cloth. Using 10 strokes on a HCl 50/a tube yielded no detectable indication, thus indicating less than about 10 ppm. With 5 strokes of vinylchlorid 1/a tube, there was a trace of an indication; the concentration was therefore roughly 0.2 ppm. With 5 strokes of HCHO/0.002 tube, there was no detectable indication, thus [HCHO] < 1 ppm.

In summary, the results indicate there is likely to be no health hazard with respect to conducting tests on brattice cloths using the HFT. Nevertheless, the wearing of respirators is required. Because of the greater mass involved, it is possible that rigid ventilation tubing will generate more toxic fumes. Unlike the brattice cloths, however, the operator does not have to handle the burner during the test on rigid ducting. A video camera could perhaps be used for these tests.

During the past few years, the propane gallery chamber was used for the "interim" large-scale test. The toxic fumes with the HFT in the new flammability room are probably much lower in concentration at the operator level than in the interim test because of the much larger total volume of the room, the higher ceiling and the fact that the sample is tested inside an enclosure.

WORKSHEET FOR HORIZONTAL FLAMMABILITY TESTER

Sample(s):_____

Date:_____

Operator #1:_____ **Operator #2:**_____

Before Starting Tests:

- ☐ Safety face-shield, safety shoes, Nomex coveralls, leather gloves
- ☐ Respirators good for organic vapours and HCl
- ☐ Flammability laboratory free from flammable materials
- ☐ Emergency door opens easily, no snow blocking exit
- ☐ Fire extinguisher in room, and at least half-full
- ☐ Regulator 8-2-250 connected to methane cylinder, leak tested
- ☐ Tube to burner in good condition and connected tightly
- ☐ Burner jets clean
- ☐ Vane anemometer and tripod
- ☐ Metal rod holder or wire
- ☐ Metal rod for lighting burner, matches and masking tape
- ☐ Aluminum foil, 4 large paper clamps, tape measure, scissors
- ☐ Water level in sump of propane gallery up to rod
- ☐ pH of water > 7
- ☐ Propane gallery turned on, not foaming
- ☐ Damper on propane gallery fully open

After tests:

- ☐ Cylinder valve closed, regulator removed, cap replaced
- ☐ Roof fan turned off
- ☐ All waste material removed
- ☐ Burner jets cleaned
- ☐ Damper on HFT closed
- ☐ Aluminum foil on floor of HFT replaced if necessary
- ☐ Damper on propane gallery closed
- ☐ Scrubber turned off